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Soil Physic Chemical Properties and Land Use and Land Cover at Agarefa, South East Ethiopia

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Abstract
Agriculture can only be sustained if soil physico-chemical properties of soils are in a good quality to cultivate crops. Investing the soil physico -chemical aspects of soils are therefore helpful in decision making for productive agriculture. The purpose of this study was to assess and measure the soil physical and chemical status of the land at Agarefa, South East Ethiopia where Weyib river is to be used as source for water for agriculture during the dry seasons. Proper field and standard laboratory procedures were followed to determine the soil physical and chemical properties of the soil in the selected study site. Accordingly, the results have showed that the land has reasonable fertile soil and can be used for irrigated agriculture

1. Introduction

Land degradation is the main environmental problem in Ethiopia. The degradation mainly manifests itself in terms of lands where the soil has either been eroded away and/or whose nutrients have been taken out to exhaustion without any replenishment, deforestation and depletion of ground and surface waters. The majority of the farmers in the rural areas of Ethiopia are subsistence oriented, cultivating impoverished soils on sloppy and marginal lands that are generally highly susceptible to soil erosion and other degrading forces. Soil erosion is a phenomenon, which mainly occurs in the highlands of Ethiopia [(areas > 1500 meters above sea level (masl)] which constitute about 46% of the total area of the country and support more than 80% of the population. It is one of the most environmentally troubled countries in the Sub Saharan belt. Generally, the principal environmental problem in Ethiopia is land degradation in the form of soil erosion, gully formation, soil fertility loss and severe soil erosion (Hurni, 1993).

In Ethiopia, soil erosion by water constitutes the most widespread and damaging process of soil degradation (Woldeamlak, 2003). It has caused several negative impacts on land (CFSCDD/MoA, 1986; EPA, 2003). Due to its favorable climate for production and presence of relatively more fertile soils as well as less disease incidence, the Ethiopian highlands host about 88% of the national population (FAO, 1986) indicating that the pressure on the resource base such as land/soil and vegetation in these regions is sever where the largest proportion of the degraded land in the country is situated in the sub-moist mid highlands where about 72% of its cultivated land is concentrated (Zewdie, 1999).Thus, land degradation remains to be the major cause of poverty in rural areas of the country. In many areas, farming populations have experienced a decline in real income due to demographic, economic, social, and environmental changes, mainly land degradation. The immediate consequence of land degradation is reduced crop yield followed by economic decline and social stress. (Greenland *et al*., 1994).

In order to make the agriculture productive and profitable, producing crops based on the capacity of the land is an alternative while improving the soil physic-chemical properties shoul be the major activity.

The objective of this paper is to present the status of the soil physic-chemical status and the land use-land cover of the selected site in the south East of Ethiopia, Agarfa.

2. Materials and Methods

The research has been undertaken at Agarefa Agricultural and Vocational College where the purpose of the work Is to generate information as supplementary input for small scale irrigation design on the nearby Weyib river

2.1. Office Work: A georeferenced topographic map and satellite imagery (Land sat 2005) for the area have been processed to obtain the current land use/land cover map of the area. Arcview GIS software has also been employed to produce classify the types of the land use of the site and similarly the areal attributes of those land use types has been defined using the same soft ware as well.

2.2. Field work: Soil sample collection was done from five representative sites after profiles have been opened. One kilogram of soils was collected from each profile at interval of 15 centimeters for use soil physical and chemical analysis and the total number of the samples was 84. Nine other undisturbed soil samples for bulk density determination from those sites have also been taken from three sites. Infiltration measurement was done using the double ring inflitrometer in the five representative sites.

2.3. Lab-Work: the soil physical properties of the samples have been determined at National Soil

Testing Center and CDS lab using the following techniques for each of the parameters. The soil samples were air dried and ground to pass through a 2-mm sieve before analysis. The soil analysis was carried out as outlined in Van Reeuwiijk(1993).

Soil texture: was determined by the modified Boyoucos hydrometer method.

PH of the soil samples: was determined by water (Ph2o) in the supernatant suspension of the soil solution ration of 1:2:5.

Organic carbon: determined using the wet combustion procedure of Wakley and Black as outlined by Van Ranst et. al (1999).

Total nitrogen: Wet-oxidation procedure of the Kjeldhal method (Bremner and Mulvaney, 1982) was followed

Available phosphorous: : was determined by 0.5 M sodium bicarbonate extraction solution (Ph 8.5) method of olsen.

Exchangeable cations and Cation exchange capacity (CEC) of the soil were determined by the 1 M ammonium acetate (Ph 7) method according to according to the percolation tube procedure.

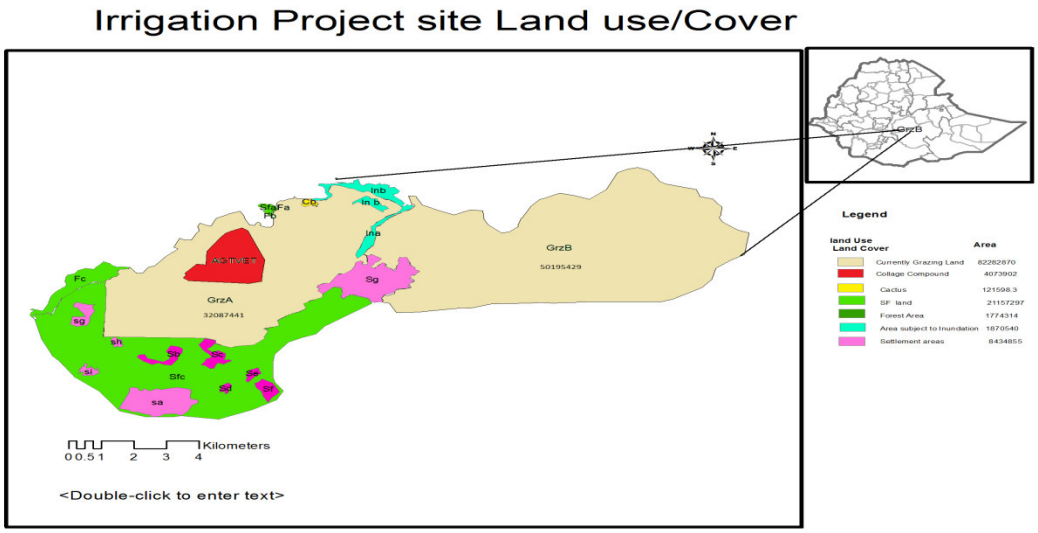
2.4. The soil mapping units and legend: mapping units were identified on the basis of two2 soil/land characteristics: depth and surface texture. Slope classes used as the first level of generalization. Soil depth followed by surface soil texture was considered to further group the land units of the farm. Land units having uniform slope, soil depth and surface texture constitute one mapping unit. The distinguishing criterion is shown in the table : 1 below

Table 1: Land surface feature

Slope		Depth		Surface Texture	
Class (%)	Code	Cm	Code	Type	Code
0-1	1	>150	a	Gray clay silt (some sand)	1
1-2	2	100-150	b	Dark brown clayey silt	2
3-5	3	50-100	c	Dark brown sandy silt	3
5-10	4	30-50	d	Brown clayey silt	4
10-15	5	<30	e		

3. Results and Discussions

The total land area identified for developing with irrigation(currenttly) is approximately 321 ha (Fgure 1).



The total land of the college can be put in to irrigation, if further expansion is needed is shown in the figure 2 below

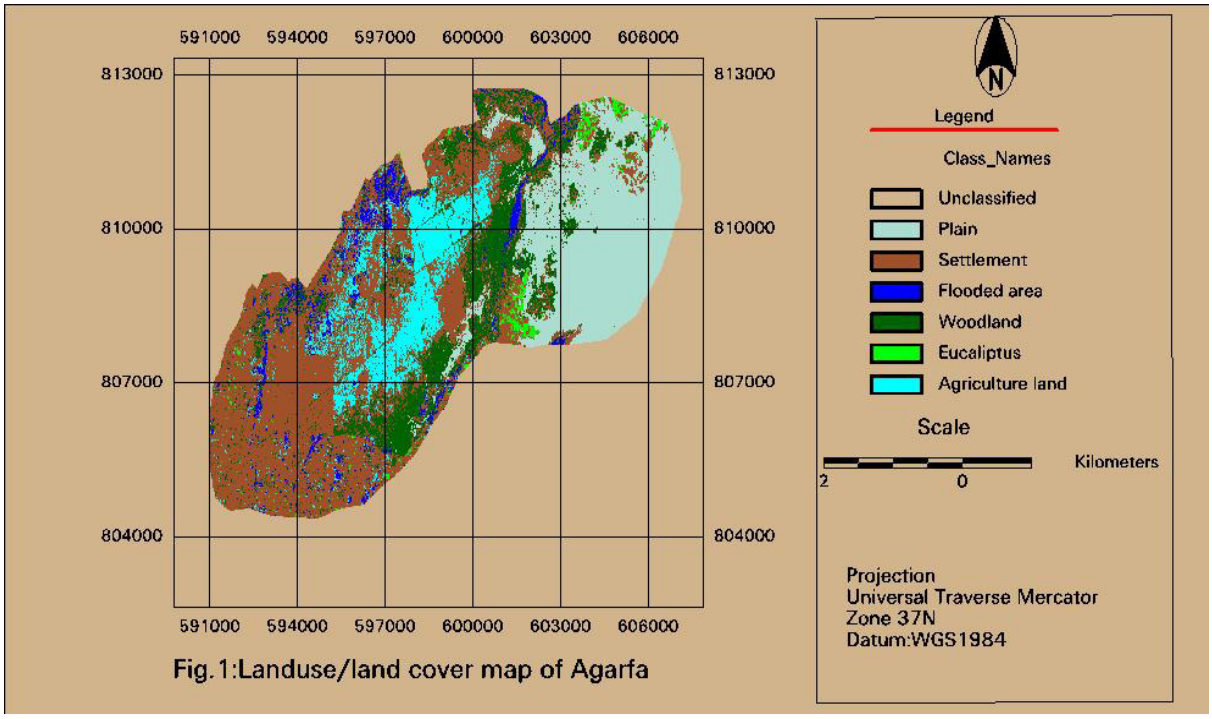


Fig.1:Landuse/land cover map of Agarfa

Class names	Area(Hectare)
Unclassified	6520.90545
Plain	1891.2429
Settlement	3531.419325
Flooded area	330.991875
Woodland	1266.054075
Eucalyptus	112.7403
Agriculture land	921.57885

The land has been classified in to 5 mapping units. Each mapping unit is indicated by a number indicating the first criterion (slope class), a lower case letter indicating the second criterion (soil depth class) code) and the number following the lower case letter indicates the surface texture (third criterion). With this understanding the mapping units are characterized as in the following:

Mapping unit 2a1

This mapping unit covers an area of 45 Ha of land, it is moderately well drained occurring on nearly level land (0 -1%). It is gray in colour. The texture of this unit is clayey silt. Soils of this have a moderate depth (Maximum of 105 Centimeters). The pH of the soil ranges from 6.3 to 7.7, it is almost a neutral soil and the EC(electrical conductivity of the soil) ranges from 0.047 to 0.248 and thus it is none saline. The cation exchange capacity of the soil (CEC) is found to be between 43.09 -54.42 C mol/Kg and base saturation level of 89-133(%). The total nitrogen of this unit is low to medium (0.04-0.21%) while the organic carbon is very low to medium (013-2.58 %). The available phosphorous is found low (0.28-1.98%). The summary of the physical and chemical properties of this unit is illustrated in table 2 of the annex of this report

Table : 1 Chemical characteristics of Mapping Unit 1

Depth(CM)	pH	EC	CEC	OM(%)	T.N	Av .P	B.sa
0-15	6.3	0.057	54.416	2.577032	0.207	1.98	88.74768
15-30	6.6	0.065	53.808	1.51787	0.1092	1.14	95.13515
30-45	6.7	0.047	54.169	1.344624	0.098	0.82	92.21704
45-60	7.1	0.061	53.732	1.254064	0.0924	0.34	97.73781
60-75	7.2	0.088	52.478	1.07688	0.1148	0.5	100.2206
75-90	7.4	0.078	43.092	0.978445	0.0462	0.28	126.7671
90-105	7.7	0.248	47.025	0.88001	0.084	0.68	132.902

Table 2: Soil Physical properties of mapping unit 1

Depth (CM)	Texture	PWP(%)	FC(%)
0-15	Clayey silt	31.47	46
15-30	Silty clay	27.12	57
30-45	Clayey silt	31.47	51
45-60	Silty clay	31.69	48
60-75	Silty clay	29.29	58
75-90	Silty clay	30.88	65
90-105	Silty clay	28.57	59

Mapping Unit 2c2:

This mapping unit has a total area of 62.5. It is generally shallow soil (up to 60 centimetres). It is dark brown clayey silt (with some sand). The pH of the soil ranges from 6.3 to 7.0, it is almost a neutral soil and the EC(electrical conductivity of the soil) ranges from 0.08 to 0.108ds/m and thus it is none saline. The cation exchange capacity of the soil (CEC) is found to be between 43.39 -51.95 C mol/Kg and base saturation level of 101-117(%). The total nitrogen of this unit is medium (0.23-0.25%) while the organic carbon is very low to medium (0.92-2.5). The available phosphorous ranged from low to medium (2.52-16.68). The summary of the physical and chemical properties of this unit is illustrated in table 3 of the annex of this report.

Table 3: Soil chemical properties of Mapping Unit 2

Depth(CM)	pH	EC	CEC	OM(%)	T.N	Av .P	B.sa
0-15	6.7	0.081	51.946	2.25	0.2128	11.14	100.70
15-30	6.8	0.083	47.386	2.25	0.2268	16.88	106.09
30-45	6.9	0.103	49.875	2.02	0.2002	13.96	106.07
45-60	7.0	0.108	48.146	0.92	0.0952	2.52	117.28

Tabel 4: Soil physical properties of Maping unit 2

Depth (CM)	Texture	PWP(%)	FC(%)
0-15	Clayey silt	34.6	43.62
15-30	Silty clay	34.8	43.62
30-45	Clayey silt	33.1	43.62
45-60	Silty clay	32.7	43.62

Mapping Unit 1a2:

This unit covers an area of 102.7 ha on nearly level land. It is a brown clayey silt type of soil. It is very deep soil. It is slightly acidic to slightly alkaline type of soil. The electrical conductivity of the soil is how ever ranges from 0.081 to 1.384 ds/m. the CEC of the soil are high (41.97-68.56 mCmol(+)/Kg). The base saturation of this soil is also very high (77-131%). The organic carbon level of the unit lies between low to high (0.79-2.33%) and the total nitrogen ranges from low to medium (0.04-0.22ppm). The available phosphorous is from very low to medium. . The summary of the physical and chemical properties of this unit is illustrated in table 3 of the annex of this report.

Table 4: Soil Chemical properties of map[ing unit 3

Depth(CM)	pH	EC	CEC	OM(%)	T.N	Av .P	B.sa
0-15	6.2	0.09	45.43	2.33	0.2212	2.66	101.78
15-30	6.1	0.091	43.15	1.86	0.175	3.2	93.00
30-45	7.9	0.188	41.97	1.46	0.1484	2.88	92.37
45-60	6.1	0.064	48.67	0.93	0.0854	0.94	82.09
60-75	6.5	0.081	53.09	0.93	0.1302	3.2	83.79
75-90	6.5	0.08	53.47	1.08	0.1358	8.38	76.84
90-105	6.5	0.093	64.66	0.88	0.0602	0.7	91.21
105-120	6.6	0.418	68.56	0.80	0.0406	1.32	92.53
120-135	7.2	1.244	65.72	0.85	0.035	0.92	99.39
135-150	7.3	1.356	66.34	0.79	0.0406	0.62	95.87

Maiping Unit 1a1:

This mapping unit covers an area of 55. 7 ha of land. It has gray clayey silt (with some sand) and it occurs on the gentle slope (1-2%). It is a very deep soil (>150 meters). The pH results indicates the soil ranges from neutral to low alkaline level (7-8) while the electrical conductivity showed a non saline condition (0.112-0.355 ds/m). The organic matter is only from low to medium (03.77-1.81%) and of that of nitrogen is relatively low (0.04-0.14%). The cation exchange capacity of the soil and base saturation are high, 49.98-54.22 Cmol (+)/Kg and 85-109% respectively. The available phosphorous level rages from 0.3-1.2 ppm

Table 6: Soil Chemical properties of Mapping Unit 4

Depth(CM)	pH	EC	CEC	OM(%)	T.N	Av .P	B.sa
0-15	7.0	0.087	50.67	1.70	0.13	2.04	94.94
15-30	7.0	0.139	58.35	1.20	0.0952	1.96	85.24
30-45	7.3	0.123	49.70	0.94	0.0672	2	105.86
45-60	7.5	0.112	56.58	0.94	0.0798	1.36	91.14
60-75	7.8	0.243	59.22	0.79	0.0602	1.1	89.09
75-90	8.0	0.252	58.71	0.70	0.062	1.32	97.41
90-105	8.0	0.285	58.51	0.72	0.049	0.96	97.79
105-120	8	0.355	54.18	0.58	0.0434	0.68	104.49
120-135	8	0.28	49.98	0.62	0.066	1.88	120.78
135-150	8	0.449	54.40	0.37	0.0364	0.88	109.40

Table 7: Soil Physical Properties of Mapping Unit 4

Depth (CM)	Texture	PWP(%)	FC(%)
0-15	Clay silt	32	46
15-30	clayeye silt	32	44
30-45	clayclayey silt	30	40.93
45-60	Clayeye silt	31	48.94
60-75	sandy clay	33	51.0101
75-90	Clayeye silt	34	43.85965
90-105	Silt clay	32	57.30994
105-120	sandy clay	42	59.44444
120-135	sandy clay	44	60.199
135-150	Silt clay	45	59.04762

Mapping Unit:

This soil unity covers a total 35 ha, and it lies on a gentle slope, having dark brown sandy silt nature. This soil is also very deep. The pH result showed a slightly alkaline condition (7.5-8) and the soil is observed to be non saline (0.167-24 ds/m). The total nitrogen and organic matter lies in the ranges 0.01-0.14 and 013-1.81 respectively. The CEC and base saturation range from 43.37-49.74 Cmol (+)/Kg and 108-112 % (very high). The available phosphorous lies in the range from medium to high (0.3-5.06ppm).

Table 8: Soil Chemical Properties of Maping Unit 5

Depth(CM)	pH	EC	CEC	OM(%)	T.N	Av .P	B.sa
0-15	7.5	0.087	50.67	1.70	0.13	2.04	94.94
15-30	7.9	0.139	58.35	1.20	0.0952	1.96	85.24
30-45	8.1	0.123	49.70	0.94	0.0672	2	105.86
45-60	8.3	0.112	56.58	0.94	0.0798	1.36	91.14
60-75	8.4	0.243	59.22	0.79	0.0602	1.1	89.09
75-90	8.2	0.252	58.71	0.70	0.062	1.32	97.41
90-105	8.5	0.285	58.51	0.72	0.049	0.96	97.79
105-120	8	0.355	54.18	0.58	0.0434	0.68	104.49
120-135	8	0.28	49.98	0.62	0.066	1.88	120.78
135-150	8	0.449	54.40	0.37	0.0364	0.88	109.40

Table 9: Soil Physical Properties of Maping Unit 5

Depth (CM)	Texture	PWP(%)	FC(%)
0-15	Sandy silt	34	46
15-30	clayeye silt	36	52
30-45	Sandy silt	37	54
45-60	Clayeye silt	39	53
60-75	Silt clay	34	49
75-90	Clayeye silt	37	54
90-105	Silt clay	32	51
105-120	clay silty	42	59
120-135	Clayeye silt	44	60
135-150	Silt clay	45	59

Conclusions

The project site is desirable for agricultural development in general because the soil nutrient level ranges from the medium to high. The lab results also showed that the land can be used for extending irrigation practices as the soil is observed non saline and also the cation exchange capacity of the soil is still very good. The sodium level as compared to the Magnesium and calcium also favors irrigated agriculture because sodium is reportedly a very dangerous cation in destructing soil structure when in found in reasonably high amount.

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